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# San Clemente Shoreline Feasibility Study
# Orange County, California

## Geotechnical Appendix

Los Angeles District
June 2004

SAN CLEMENTE BEACH REPLENISHMENT
F-3 FEASIBILITY STUDY

GEOTECHNICAL APPENDIX

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## 1. INTRODUCTION

## 2. PURPOSE AND SCOPE

The purpose of this appendix is to provide the basic data and requirements necessary to support the feasibility study for the Corps of Engineers dredging of offshore beach sand and disposing of the material on the beach at San Clemente, California. This report provides a review of the existing literature and analyses, which include geophysical investigation, exploratory drilling and chemical and physical analysis of the offshore sediment.

## 3. LOCATION

San Clemente, California, is located along the pacific coast in the southern edge of Orange County. The proposed borrow areas for the beach replenishment are located north of Oceanside, California, in the northern edge of adjacent San Diego County, approximately 1.73 kilometers (1 mile) north of Oceanside Harbor. See Plate 1 for the borrow areas and Plate 2 for the location of the San Clemente beach.

## 4. REGIONAL PHYSIOGRAPHY AND TOPOGRAPHY – ONSHORE

The San Clemente area comprises a part of the western flank of the Peninsular Ranges Geologic Province of southern California and includes areas of the western foothills of the Santa Ana Mountains and the southeastern flank of the San Joaquin Hills. The Peninsular Ranges extend from the Palos Verdes Peninsula in the north to the tip of Baja California in the south. The bedrock exposures in the area are comprised of marine sedimentary and volcanic rocks of Miocene, Pliocene and Pleistocene age. The bedrock formations both onshore and offshore consist of the San Mateo Formation, an arkosic sandstone of Pleistocene age; the Capistrano Formation, a series of silty shales, mudstones, siltstones and coarse sandstones of late Miocene and early Pliocene age, and the San Onofre Breccia which is a series of volcanic breccias, ash flows and tuffs derived from large landslides during volcanic eruptions interbedded with layers of fine-grained volcanic ash deposited into fresh or salt water and is of Miocene age.

## 5. SITE GEOLOGY AND TOPOGRAPHY – ONSHORE

On the San Clemente beach marine erosion has formed a broad wave-cut terrace which extends back from the coastline and lies several meters above sea level. This relatively flat lying surface is cut mainly in rocks of the Capistrano Formation of late Miocene and early Pliocene age and is mantled with poorly consolidated non-marine alluvial cover of Holocene and Pleistocene age and marine terrace deposits of Upper Pleistocene age. The non-marine cover consists of poorly bedded fine-grained sediments. The marine terrace deposits consist of poorly consolidated sands, sandstones and conglomerates. The beach which begins at the foot of the wave-cut terrace is composed of fine to medium grained sands and silty sands. Because of various seasonal cycles of sand deposition and erosion and the lack of adequate natural beach renourishment, the beach has eroded and varies in width from 0 to 60 meters (0 to 200 feet). Table 1 lists the 10 reaches of San Clemente Beach and the beach width range, from Station 0+146 at San Mateo Point to Station

7+109 at Dana Point Harbor. See the Coastal Engineering Appendix for more details about the width of the beach at each reach.

## 6. SITE GEOLOGY AND BATHYMETRY – OFFSHORE

The area offshore of San Clemente is a part of the Capistrano Bight, located at the eastern edge of the Gulf of Santa Catalina. This area is described as that part of the California coast known as the "Continental Borderland" as there is no real continental shelf in this part of the coast. The area from Dana Point Harbor in Orange County downcoast to La Jolla in San Diego County is further defined as the "Oceanside Littoral Cell". San Clemente beach is located in the extreme upper portion of this Littoral Cell. Published information for the bedrock exposures of most of the offshore area, exclusive of San Clemente Beach and the Channel Islands is sparse and is based upon scattered bottom samples and reconnaissance type geophysical investigations. Local lifeguards and divers have informally stated that the ocean floor area offshore contained only bedrock and there were no deposits of beach sand. In May 2002, bathymetric surveys, seismic surveys, sub-bottom profiling and a side scan sonar survey were conducted offshore of San Clemente beach to determine the presence or absence of shallow bedrock. The bathymetric survey indicates that the ocean bottom slopes gradually seawards for a distance of about 1,500 meters (0.9 mile) from elevation 0 MLLW at the shoreline to an elevation deeper than -32.8 meters (-100 feet) MLLW. The accompanying geophysical surveys further indicated that the ocean floor is a bedrock surface covered with a thin veneer of littoral sediments that vary in thickness from about 0 to approximately 0.32 meters (1-foot) or more, out to a distance of 1,500 meters from the shoreline. The sediments are described as silty sands and sandy silts as determined by both the geophysical surveys conducted in the summer of 2002 and core samples derived from six vibracore test holes conducted in January 2003. The vibracore holes were placed and sampled at random locations offshore of the City of San Clemente, from the vicinity of the San Clemente Pier downcoast to San Mateo Point (the Orange County-San Diego County Line). The test holes were placed at least 0.61 kilometers (one mile) offshore in order to avoid the shallow bedrock encountered by the seismic survey. Most of the holes were sampled at a mud line elevation of -16.4 meters (-50 feet) MLLW, which is the limit of the most economical dredging operations. The exploration indicated that at approximately one-mile (1.73 kilometers) seawards of the beach, the bedrock is still fairly shallow and was encountered between -1.3 meters (- 4 feet) and -3.3 meters (-10 feet) below the mudline. The sediments encountered overlying the bedrock were silts and fine-grained sands, visually deemed unsuitable for beach replenishment. The exploration program was moved to Oceanside near the mouth of the Santa Margarita River, where previous reconnaissance exploration had indicated suitable material. See the paragraph entitled "Field Exploration Studies" for further details.

## 7. SOURCES OF SAND REPLENISHMENT – OFFSHORE

The primary natural sand supply for the beaches on the Pacific Coast is provided by the rivers and streams which transport the sediment to the coast during the winter and spring storms. Eroding sea cliffs and bluffs provide a secondary source of sediment. The waves and currents distribute the sand as it is deposited at the coast. The adjacent beaches are replenished as the flow of sand moves alongshore. The predominate direction of the sand movement along southern California beaches is north to south, notwithstanding seasonal local variations. Generally the best

places to find suitable beach sand for replenishment are at the deltas of the various streams that empty into the ocean. There are no such streams in the vicinity of San Clemente except for the mouth of San Juan Creek, which empties into the ocean at Capistrano Beach, which is south of Dana Point and north of San Clemente. Prior exploration by others have indicated that the sediments at this location are too fine-grained and are unsuitable for beach replenishment. Accordingly, in January 2003 a vibracore exploration was first conducted about 1.73 kilometers (1 mile) offshore of San Clemente beach for a distance of about 3 to 3.6 kilometers (5-5.6 miles) parallel to the coastline to determine if suitable sand was present. The results were negative; therefore the exploration was moved offshore to a new location near the mouth of the Santa Margarita River, a few miles northwest of Oceanside Harbor. The results of the entire exploration are found in the paragraph entitled “Field Exploration Studies”. See Plate 1 for the Plan of Exploration and Figures 1 and 4-8 for the logs of the vibracore holes located offshore of San Clemente beach.

## 8. SOURCES OF SAND REPLENISHMENT – ONSHORE

The only suitable source for beach sand would be at Camp Pendleton which is located between San Clemente and Oceanside or perhaps somewhere in the watershed of the San Juan River, near San Juan Capistrano. At the present time, exploration in Camp Pendleton is being considered in only one location behind a debris basin. However, use of this source would require several trucks transporting the sand to San Clemente via residential streets. Use of this sand source would also depend upon the U. S. Marine Corps allowing the trucks onto the Base to remove the sand. The Marine Corps only allows the removal of sand behind the debris basin at certain times: however, at the time of this study the sand was not available. Funding is presently not available to explore for sand at the San Juan River.

## 9. GEOLOGIC HAZARDS

There have been several landslides mapped in the hills and mountains that form the eastern boundary of San Clemente Beach. These are shown on a geologic map accompanying “Natural Slope Stability as Related to Geology, San Clemente Area, Orange and San Diego Counties, California, Special Report 98 (Blanc and Cleveland, 1968) published by the California Division of Mines and Geology. The geologic map indicates that there are seven small areas of the bluff behind the beach, extending from the San Clemente Pier to San Mateo Point, which contain landslide deposits. None of these slides extend all of the way onto the beach so they are not a potential problem for beach nourishment. Neither the literature search nor the offshore seismic and side-scan sonar surveys indicate any landslides offshore of the beach.

## 10. FAULTS

All of southern California including the San Clemente area is seismically active. There are several major NW-SE trending faults in both the onshore and the offshore areas east and west of San Clemente. The Whittier-Elsinore, Agua Caliente, San Jacinto and the San Andreas Fault zones are located approximately 12.3 kilometers (20 miles), 16.5 kilometers (27 miles), 24.4 kilometers (40 miles) and 38 kilometers (62 miles) northeast of San Clemente, respectively. The Newport-Inglewood–Rose Canyon Fault lies approximately 3.1 kilometers (5 miles) offshore of

the beach. The Palos Verdes Fault zone parallels the pacific coast offshore from the San Pedro – Long Beach area to La Jolla, and lies about 10.3 kilometers (18 miles) from the coastline. The San Clemente Island Fault zone lies approximately 33 kilometers (55 miles) offshore and is parallel to the Newport-Inglewood-Rose Canyon Fault zone. These three faults trend parallel to the onshore faults. The Christianitos Fault which is the closest fault to the project area, trends NW-SE and passes through the mountain ranges behind the San Clemente area and trends down San Mateo Creek and goes offshore to parallel the coastline near San Onofre in a southerly direction past Oceanside. The fault is located approximately ½ to 3 kilometers (1-5 miles) offshore of San Clemente beach. Any earthquakes caused by movement along these or other nearby faults would have little effect upon the new sand placed on the beach for replenishment.

## 11. FIELD EXPLORATION STUDIES – SAN CLEMENTE AREA

In June 2002, Fugro-West, Inc., a Geotechnical Engineering Consultant performed a geophysical Subbottom profile; Side Scan Sonar and a Multibeam Bathymetric Survey off the coast at San Clemente Beach for the Los Angeles District of the Corps of Engineers (Contract No. DACW09-00-D-0023). The survey began at San Juan Creek near Dana Point (Capistrano Beach) and extended downcoast to San Mateo Point, a distance of approximately 14 kilometers. The survey began at the surf zone and concluded seaward at approximately 19 meters water depth (about 58 feet). The geophysical surveys were performed in order to determine if shallow bedrock existed on the ocean floor between the shoreline and one-mile (1.6 kilometers) seaward. The Subbottom Profile was conducted in order to delineate the stratigraphic conditions, the presence or absence of sandy materials, to delineate the boundaries separating the consolidated from the unconsolidated materials and to define the depth to bedrock, if it existed. The various geophysical surveys indicated that the shallow bedrock formed the ocean floor for at least 1.6 kilometers (one mile) seaward from the coastline.

In 1982-1983 the State of California, Department of Boating and Waterways (DBW) employed a private contractor to sample a series of vibracore holes, spaced 1.6 kilometers (one mile) apart from the upcoast limit of Capistrano Beach to the downcoast limits of San Mateo Point (the Orange-San Diego County Line), approximately 1.6 kilometers (1 mile) offshore. The results of their exploration program revealed that the area contained poor to non-existent deposits of suitable beach sand. In January 2003, six vibracore holes were sampled by the Los Angeles District approximately 1.6 kilometers. (1 mile) offshore of San Clemente beach. The purpose of the 2003 exploration was also reconnaissance in nature, and consisted of spacing the new vibracore holes between the older DBW holes in approximately the same area to see if suitable sand could be found in the areas which were unexplored. These new vibracore holes encountered silts and fine-grained sands overlying hard bedrock at depths varying from 1.7 meters (5.1 feet) to 3.9 meters (12 feet), verifying the earlier exploration results, which indicated that suitable sand deposits did not exist at that elevation and distance from the shoreline. The elevations of the mudline at the holes varied from -17.7 meters (-54 feet) MLLW to -20.4 meters (-62.2 feet) MLLW. See Figure 1 for the Beach Sand Gradations and Figures 4 through 8 for the logs of these holes. The following day, the exploration was moved downcoast several miles to San Diego County and resumed at the mouth of the Santa Margarita River, a short distance north (upcoast) of Oceanside Harbor. No further exploration was attempted offshore of San Clemente Beach.

## 12. FIELD EXPLORATION STUDIES – OCEANSIDE AREA

In January 2003 after the exploration program at San Clemente failed to find suitable material, 25 vibracore holes were sampled by the Los Angeles District at the mouth of the Santa Margarita River, north of Oceanside Harbor. The proposed borrow area extends from Loma Alta Creek (in Oceanside) in the south to the mouth of the Santa Margarita River in the north. See Plate 1 for the location of the proposed borrow area. These holes varied in depth from approximately 11.2 meters (34.2 feet) to 17.6 meters (53.7 feet). The exploration covered an area approximately 1,050 meters (3,200 feet) and 394 meters (1,200 feet) wide. The materials were described and classified as fine to medium grained sands with local silty intervals and laterally discontinuous beds and lenses of gravel and cobbles. These lenses generally averaged 0.65 meters (2 feet) or less. See Figures 9 through 37 for the logs and Figure 1 for the Beach Sand Gradations of these holes. The majority of the material appeared to be compatible.

In August 2003, 25 additional vibracore holes were sampled at Oceanside Beach for a beach replenishment study. The purpose of the study was to determine if there was a sufficient amount of suitable sand for a beach replenishment program at both San Clemente and Oceanside. The depth of the holes varied from approximately 14.8 meters (48.5 feet) to 24.1 meters (70.2 feet). These holes were explored and sampled in the same proposed borrow area, but were placed to fill in the gaps between prior holes and to obtain more information about certain reaches of the area. See Plate 1 for the Plan of Exploration and Figures 2 for the Beach Sand Gradations, and Figures 38 through 63 for the logs of these holes.

In 1999, SANDAG explored and sampled 35 vibracore holes in this same proposed borrow area. These vibracore holes varied in depth from approximately 1.2 meters (3.6 feet) to 6.5 meters (17.2 feet). The mudline elevations of the holes varied from approximately 16 meters (49 feet) MLLW to 22.9 meters (70 feet). The material was sampled, analyzed and classified as a top surficial layer of sandy silt about 3.9 meters (12 feet) thick underlain by a layer of suitable beach sand, approximately 1 meter (3 feet) to 4.2 meters (13 feet) thick.

SANDAG later dredged some of the material in water deeper than –16.4 meters (50 feet) and placed the material on various locations of the beach in Oceanside and surrounding vicinity. See Figure 3 for the gradation and summary sheet for the logs of these holes. See Figures 64 through 98 for the logs of these holes. See Appendix A for the laboratory results and the gradation curves for all of the above holes.

## 13. ANALYSIS OF THE OCEANSIDE AND THE SAN CLEMENTE BORROW AREAS

Details of the January and August 2003 vibratory core explorations can be found in Raabe (2003, 2004). As part of the contract for the January 2003 program, Group Delta, a geotechnical engineering consultant, produced a report of project activities and results therein, entitled “Vibracore Exploration Program, San Clemente Beach Shoreline, Orange and San Diego Counties, California” (Group Delta, 2003) for the Geotechnical Branch of the Los Angeles District. Appendices to this report include:

Appendix A  Field Exploration
Appendix B  Core Penetration Logs

Appendix C  Physical Test Results
Appendix D  Chemical Test Results
Appendix E  Photographic Documentation

San Clemente (Borrow Area #1). Sampled materials encountered at Borrow Site #1 were generally greenish-gray silty, very fine-grained sands and sandy silts with minor amounts of shell fragments. A soft, micaceous wackestone bedrock was encountered in (possibly four) of the holes, causing refusal of the vibracore. These materials appeared to be too fine-grained for beach nourishment purposes. Samples for chemical analysis were not collected, as the recovered sediments were too fine to be placed onto the beach.

Physical tests were performed on eight selected samples from this borrow area. Group Delta reported that the samples show an average of 0.9% gravel, 51.5% sand and 47.6% fines passing the No. 200 sieve. The percent fines ranged from 21% to 67%. These values show that the sampled area off of San Clemente Beach does not contain suitable compatible beach replenishment material.

Oceanside (Borrow Area #2). The sampled materials were generally fine-grained sands with local silty intervals and minor amounts of shell fragments. Significant laterally discontinuous gravel/cobble beds and lenses were encountered throughout the area, but the thickness generally averaged 2-feet (0.65 meters) or less. Often the gravel intervals possessed supporting dense silty sand material, which acted as a “pavement” holding the cobbles tightly, making the core penetration difficult. Shell and shell fragments were encountered throughout the area.

Twenty-five of the samples from the January 2003 exploration were combined into a single composite sample for the chemical analysis. A full tabulation of the results can be found in Appendix D of the Group Delta Report (Group Delta, 2003). All of the analyzed constituents were well below allowable limits. Table 2 is a summary of the results of the chemical analysis of these samples. No samples were collected for chemical analysis during the August 2003 exploration.

Physical tests were performed on 91 samples from this borrow area. The samples show an average of 12.3% gravel, 81.4% sand and 6.3% fines passing the No. 200 sieve. Figures 1 and 2 show the results of gradation testing, as well as weighted averages for each test hole. As displayed in these figures, 25 out of the 27 test holes within the Oceanside site are beach-compatible, with the total fines of 12% or less.

## 14.  BORROW AREA VOLUME CALCULATION

A preliminary estimate of the volume of beach-compatible material was computed for the proposed borrow area #2 upcoast of Oceanside Harbor. The volume was calculated for a -4.6 meter (15-foot) dredge depth, except in the deeper (seaward) portions of the area, where the bottom of the calculated volume was -19.7 meters (-60 feet) MLLW. The upper or nearshore limit was -8.2 meters (-25 feet) MLLW. The northern, western and southern limits are delineated by increasing siltier materials. The western margin is not constrained by material composition, only by depth. Using these criteria, an approximate calculation yields approximately 15,650,000

cubic meters (20,500,00 cubic yards) of beach-compatible material. Further calculations using shallow dredge depths will result in lesser volumes. The dense siltier, cobble-rich layers encountered at or near the surface will present slight to moderate difficulty for dredging operations.

See Plate 1 for the Plan of Exploration that shows the locations of the vibracore holes, Figures 4 through 98 for the logs of all of the holes, and Figures 99 through 124 for the Generalized Soil Profiles of the proposed borrow area. See Appendix A for the laboratory analysis results and the gradation curves for the above holes.

## 15. BEACH COMPATIBILITY STUDIES

At a later time eight transects will be surveyed and sampled spaced evenly throughout the proposed five-mile long receiving beach, from elevations +3.9 meters (+12 feet), +1.9 meters (+6 feet) 0 meters (0 feet), -1.9 meters (-6 feet), -3.9 meters (-12 feet), -5.9 meters (-18 feet), -7.9 meters (-24 feet) and -9.8 meters (-30 feet) and the results will be included in the F-4 Report. Grab samples of the sediment will be collected at each station, to be analyzed and classified by the Los Angeles District Soils Laboratory.

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